

Introduction to Plant biotechnology

Introduction to Plant Biotechnology

Basic Idea / Meaning

- **Plant biotechnology** is a branch of science that uses plants or their parts to produce useful products through laboratory techniques.



- It involves the use of:
 - Whole plants
 - Plant tissues
 - Plant cells
 - Plant organs (roots, leaves, etc.)

Related Fields

- **Plant biotechnology combines knowledge from:**
 - **Botany** – study of plants
 - **Genetics** – study of genes and heredity
 - **Molecular biology** – study of DNA and proteins

Main Goals

- Improve plant quality
- Increase production of useful compounds
- Develop disease-resistant plants
- Produce medicines from plants
- Solving agricultural and health-related problems

Key Features

- Uses living plant cells or tissues
- **Works at different levels:**
 - Whole plant level
 - Tissue level
 - Cellular level
 - Molecular (DNA) level
- Performed under highly controlled laboratory conditions

Important Techniques Used

- **Tissue culture** – growing plant cells or tissues in the lab
- **Micropropagation** – rapid multiplication of plants
- **Genetic engineering** – modifying plant genes
- **Molecular markers** – identifying plants using DNA

Advantages / Importance

- Faster plant growth
- Large-scale production of plants and compounds
- Production of rare medicinal compounds
- Reduces dependence on wild plants
- Ensures uniform quality of plant products
- No seasonal limitations due to controlled conditions

Historical Perspectives of Plant Biotechnology

1. Early Human Practices (Ancient Period)

- **Humans used plants for:**
 - Food
 - Medicine
- **Early methods included:** Selection of better plants (natural or selective breeding)
- There was no scientific knowledge of genes or inheritance

2. Pre-Mendelian Period

- **Farmers improved crops through:** Selective breeding
- Traits were improved, but the mechanism of inheritance was unknown

3. Mendelian Era (19th Century)

- **1865:** Gregor Mendel introduced the laws of inheritance
- Explained how traits are passed from one generation to another
- **Introduced concepts like:** Dominant and recessive traits
- Laid the foundation of modern genetics

4. Discovery Phase (Cell and Genetics)

- **1665: Robert Hooke discovered cells**
 - Showed that plants are made of cells
- **Early 20th century developments:**
 - Discovery of chromosomes
 - Identification of genes on chromosomes
 - Beginning of modern genetics

5. Development of Plant Tissue Culture

- **Concept:** A small part of a plant can grow into a whole plant
- **Important Milestones:**
 - **1902:**
 - Haberland proposed the idea of tissue culture
 - **1950s:**
 - Successful growth of plant tissues in the laboratory
 - Development of nutrient media

6. Molecular Biology Era (Mid-Late 20th Century)

- **1953:** Watson and Crick described the structure of DNA
- Understanding of genetic code and molecular biology advanced
- **Genetic Engineering:**
 - **1970s:** Development of recombinant DNA technology
 - **1980s:** First genetically modified (GM) plants produced

7. Modern Era (Recent Developments)

- **Advanced technologies include:**
 - CRISPR gene editing
 - Genomics and Proteomics
- **Applications include:**
 - Production of transgenic plants

- Plant-based vaccines and pharmaceuticals

Prospects of Plant Biotechnology as a Source of Medicinal Agents

Importance of Medicinal Plants

- Plants produce special chemicals called **secondary metabolites**
- These are not required for plant survival but are useful for humans

Examples:

- **Alkaloids** – morphine, quinine
- **Glycosides** – digoxin
- **Terpenoids** – artemisinin
- **Flavonoids** – various therapeutic uses

Limitations of Traditional Methods

- Slow growth of plants
- Seasonal availability
- Overharvesting may lead to extinction
- Variation in quality and quantity of compounds

Advantages of Plant Biotechnology

A. Controlled Production

- Compounds can be produced in laboratory conditions
- Not affected by climate or seasons

B. High Yield

- Genetic modification increases production
- Selection of high-producing cells

C. Consistent Quality

- Uniform conditions lead to uniform product quality

Techniques Used

1. Plant Tissue Culture

- Growing plant cells or tissues in nutrient medium
- **Used for:**

- Mass production
- Secondary metabolite production
- No need for whole plants

2. Cell Suspension Culture

- Cells grown in liquid medium
- Easier to scale up for large production

3. Hairy Root Culture

- Fast-growing roots
- High production of metabolites

4. Genetic Engineering

- Inserting genes responsible for drug production
- Helps increase yield and efficiency

Improvement of Medicinal Compound Production

A. Biotechnology helpsto:

- Increase quantity of active compounds
- Improve drug quality

B. Achieved by:

- Gene manipulation
- Optimizing growth conditions

Molecular Farming

- **Plants are used as “factories” to produce:**
 - Vaccines
 - Antibodies
 - Therapeutic proteins

Conservation of Medicinal Plants

- Rare and endangered plants can be protected using:
 - **In vitro conservation**
 - **Cryopreservation**

Examples of Important Plant-Based Drugs

- **Taxol** – anticancer drug
- **Vincristine** – used in chemotherapy

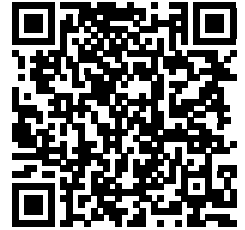


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